Journal of the Society of Arts.

FRIDAY, DECEMBER 12, 1856.

FOURTH ORDINARY MEETING.

WEDNESDAY, DEC. 10, 1856.

The Fourth Ordinary Meeting of the One Hundred and Third Session was held on Wednesday, the 10th inst., Dr. Lyon Playfair, C.B., F.R.S., in the chair.

The following Candidates were balloted for, and duly elected members of the Society:—

Chowne, William D., M.D.
Critchett, George
Dove, William
Eassie, William
Gill, Robert
Moore, William
Pope, William Agnew
Sharp, Joseph Budworth
Shute, T. R.
Squier, E. George
Thring, Edward

The following Schools have been taken into Union since the last announcement:—

Clarendon House School (Lambeth).
Ing's House Academy (Wakefield).

A transparent glass ventilator, and specimens of glazing in painted glass, obviating the necessity of a large proportion of the lead joints at present used, were exhibited by Mr. W. Cooper.

The Paper read was:—

ON THE UTILISATION OF THE SEWAGE OF TOWNS BY THE DEODORISING PROCESS ESTABLISHED AT LEICESTER, AND THE ECONOMICAL APPLICATION OF IT TO THE METROPOLIS.

BY MR. W. FOTHERGILL COOKE.

I am to have the honour this evening, in compliance with a request from the Council, of addressing the Society on the important subject of the utilisation of the sewage of our larger towns for agricultural purposes. The proposition includes, not only the converting of putrifying refuse matter, rich in the food of vegetable life, to a useful purpose, but also the purification of our streams, and the improved health of the crowded population of our streets.

This three-fold good may be attained in different ways—1st., by employing the sewage as it passes from the town, to flood or water the land. 2nd. By separating chemically and mechanically both the salts dissolved and solid matter suspended in the sewage, allowing the putrified water to flow off into its natural channel-beds, whilst the solid residuum is prepared in a convenient form for agricultural use.

The plan of irrigating by sewage water has long been in operation on a small scale at Edinburgh and elsewhere, with the most satisfactory agricultural results; and the deodorising system has, so far as its sanitary and manufacturing results are concerned, achieved a perfect success at Leicester.

There the entire sewage of a population of 65,000 has been operated upon since May, 1855, to the present day, and 6,000 tons of solid matter have been separated from seven or eight million tons of sewage. We have, then, in both cases, practical facts, not theoretical schemes, to deal with, but the commercial question, whether the sewage will bear the cost of conveyance and distribution, and the solid manure the cost of manufacture, remains to be determined.

It is my intention in this paper to consider the subject of deodorising sewage with especial regard to the drainage question of the metropolis, in which case the commercial value of the solid matter is of minor importance, provided that the deodorising system offers as an equivalent a large saving of capital in the requisite works, and still more important sanitary advantages. But I hope to prove, that in dealing with the enormous amount of sewage produced in this metropolis, it is by a combination of the fluid and solid plans that the most beneficial results will be arrived at both to town and country.

I do not, however, mean to shrink from discussing the question of agricultural value in the deposit, and I take this early opportunity of stating my belief that the solid sewage has sufficient value as a manure to insure a sale at a price which will cover the very low cost of production, and in due order I will state facts on which I have formed that opinion.

Having mentioned that fluid sewage has been most advantageously applied to land (especially meadow land and crops of Italian rye grass) under particular circumstances of season and locality, I desire, before I proceed to describe the deodorising system, to state my reasons for thinking that no method yet proposed for the employment of unprepared fluid sewage is applicable on a large scale to the metropolitan district, and then in due order, I shall have an opportunity of pointing out how the objections to the fluid system may be obviated, by working it in conjunction with deodorisation.

The supply of fluid sewage being constant, it should be dealt with constantly; it cannot be accumulated or stored up. But the farmer cannot constantly employ it. He cannot employ it where his ripening crops are standing, nor during frosts—nor will he desire it when long continued rains or deep snows have soddened his heavy clays. During the dry winds of March, and after the hay harvest in June, he will gladly take a full supply; and again, during the autumn season of continued drought and with bare fields, all the farmers of the district would be clamorous for a portion of the then stinted stream of sewage, shrunk by the same drought below its average amount.

The sewage of the metropolis is said to contain some 10,000 tons of ammonia, a quantity which would suffice to supply with ammonia about 500 square miles of land annually. But the sewage containing that quantity of ammonia would be too small to be distributed equally over the land; and, practically, one square mile daily would be the largest surface that could be dressed with sewage. The demand during the dry season would exceed this. The idea that naturally suggests itself is, let a reservoir be made that shall store-up the accumulation of the previous season. But the reservoir required for only one day's supply of sewage during dry weather must measure more than 12 million of cubic feet, and would occupy some 31 acres of land ten feet in depth, and such a reservoir, with its putrescent exhalations, must be hermetically sealed up.

Such a project is obviously impracticable. The sewage, when not required for irrigation, must either run to waste or be differently treated.

But even without such a storing of putrescent matter, would there be no danger to the health of the country population in having several square miles of land between London and the Thames' mouth soaking, or drying after a soaking, with fermenting sewage-dressing *leaving* on the surface a scum of putrifying organic matter under a burning July sun,—a gentle easterly breeze wafting the fragrance over the metropolis during the dog-days, mixed with the miasma of the Essex marshes?

The open sewage canal by which it has been proposed to convey the sewage to the Essex farmers, would in itself be a serious evil. It would expose to the air a surface of

sewage extending over 45 acres in a course of 20 miles, and would be liable, in winter, to be frozen or choked up with snow.

Before a system of fluid manuring be adopted in the county of Essex, it behoves the authorities generally to consider whether the effluvia from an extensive area, saturated with stale sewage, poisoning the atmosphere by putrifying and steaming during the heat of summer, might not be as injurious to the health of Kent and Essex—aye, and of the metropolis itself, as the most efficient subterranean removal of sewage could be beneficial to the health of London and Middlesex.

Now let me turn, in contrast, to the deodorising system:—

The leading feature of the deodorising system is, that it does not deal with highly putrescent sewage, abounding with liberated ammonia, but with the fresh sewage as it descends in the sewer, before putrescence has made any material advance, and it is in that state, and before the sewage leaves its underground course to enter the deposit reservoir, that it is intimately blended with cream of lime, which instantly deprives the sewage of all odour, and precipitates almost the whole of the salts and solid matter contained in it to the bottom of a reservoir, from which it is removed again, always under the cover of several feet of scentless water, through covered channels to filter frames, and in these filter frames the consolidating process is completed.

Here is a bottle of the stygian stream flowing day and night through the deep sewers of Leicester, 18 feet below the level of the ground. In the act of being pumped up from the sewer, it is mixed with the substance contained in this bottle (the cream of lime) in proportions varying from 2 to 16 grains to a gallon, which instantly deodorises it, and gives the mixture the appearance you observe in this bottle. A rapid separation takes place, and the limpid effluent water, of which this is a sample, flows into the river, and leaves behind it a deposit which, upon being dried, is converted into this inodorous powder.

Before proceeding to describe, by the aid of drawings and models, the process, arranged and perfected by Mr. Wicksteed, at Leicester (to whom we are indebted for conceiving and working out the system), I will give in a few words the early history of the undertaking.

As far back as 1845, Mr. Thomas Wicksteed, formerly engineer to the East London Waterworks, a name well and honourably known in connexion with questions of water-supply and sewerage, was called upon to examine whether there might not be some practical and profitable mode of dealing with the sewage of London, and brought forward, at the suggestion of the late Professor Aikin, a scheme for separating, by means of lime, the solid matters and salts contained in sewage water, so as to render them portable and to apply them to fertilizing the soil, whilst the effluent water was discharged, free from all impurity.

Continuing to bestow for several years much attention to this subject, he introduced various practical improvements, which elicited a very favourable opinion from Mr. Robert Stephenson, corroborated by Professors Aikin and Taylor. A few gentlemen interested in the general question of the improvement of the salubrity of towns, subscribed £2,500 to try its efficiency by an experiment on a large scale at Leicester.

The result proved eminently successful; an act of incorporation was, consequently, obtained, and an engagement entered into with the authorities of Leicester, a town of 65,000 inhabitants, and full of manufactories, to purify its whole sewage, for which Mr. Wicksteed had also originated a plan of artificial drainage. This last-mentioned improvement was nearly completed in May, 1855, and the deodorizing works, which after numerous preliminary essays had been simultaneously executed, were then brought into full operation. Since that period the works have been in constant operation day and night, and in the course of nineteen months have separated about 6,000 tons of solid matter, from seven-and-a-half millions of tons of sewage, discharging only pure water into the river Soar, which the mass of separated impurity would otherwise have contaminated.

The sewage is conveyed to a spot less than a mile distant from the town of Leicester, and there, as rapidly as it arrives, and scarcely allowing time even for incipient putrefaction, it is raised eighteen feet, by pumps worked by steam power. Whilst passing from the pumps the sewage becomes intimately mixed with a body of lime and water, proportioned to, and constantly varying with, the nature of the sewage, which produces an instantaneous and perfect deodorisation. It then flows successively through two canals; the first 60 and the other 130 feet long, 45 feet broad, and 16 deep, which are traversed by the sewage water in about two hours and a-half, and the water which emerges when the lime has been well-proportioned is almost pure, and perfectly scentless, whilst the greater portion, or about seven-eighths of the solid matter originally held in solution or suspension, is deposited as fine mud in a trench at the bottom of the first canal, from which, by an Archimedes, or endless screw, the fresh deposit is moved by a continued action from beneath the deep stratum of the deodorised water, into a covered well. Thence it is lifted through a brick shaft to a small tank, in the upper part of the building, by a Jacob's ladder, similar in principle to the ladder of buckets used in dredging machines. A series of centrifugal machines are then charged with it, and effect the separation of the remaining water, leaving the deposit in a plastic state, fit to be formed into a brick or cake for drying. At present nearly 3,000 tons of this half-dry deposit are heaped up in the yard of the Leicester works, and emit no smell whatever.

For the interior of towns, where it is desirable that the operation should be closed in, a new patent filter, manufacturing about two tons of solid matter at one operation, is preferable to the centrifugal machines. The filter system admits of no communication whatever with the atmosphere, at any stage of the operation, until the deposit is withdrawn from it in the form of flat firm slabs, forty inches square and three inches thick, to be dropped from the press into a barge for daily removal. A full-sized filter would manufacture about eight tons daily, and three men and a boy could manage twenty to twenty-four filters. The following results are thus easily attained.

1st. The solid matter and salts held in suspension and solution in fresh sewage water, can be deposited by the chemical and mechanical action of lime before putrefaction commences, and can be manipulated in closed works and without exposure to the outer air, up to the moment of their conversion into firm inoffensive slabs, well suited for removal; a boat or cart-load of which, would be quite as unobjectionable as one of unburnt tiles or bricks.

2nd. The deodorized water, after passing through the first short canal of sixty feet in length, which may be viewed in the light of an enlarged continuation of the sewer itself, is so free from solid matter that it might be employed for flushing or diluting a lower line of sewers. To fit the deodorized water for street watering or for being discharged into an open river as at Leicester, it must be passed through a second canal from 130 to 250 feet in length, according to the degree of transparency desired. It must be borne in mind that after being thoroughly mixed with the lime the water is without smell, and therefore no longer requires to be vaulted over, but may be exposed to the atmosphere in an open channel where desirable.

In speaking of these channels, whether built-in or open, I have employed the term "canal," with the view of dissociating them from the idea of stagnant cesspools. There is no analogy whatever between them and the cesspool-reservoirs or vast vaults of deposit to be formed on the banks of the Thames. It can hardly be doubted that the frequent necessity for cleaning out a pestilential accumulation of semi-liquid sewage from these last, would

be an operation impossible to execute in any ordinary way.

The inhabitants of this great city, in maintaining their vitality consume about 12,000 tons of nitrogen annually, equal to about 15,000 tons of ammonia, 10,000 tons of which are, as I have before stated, carried off by the sewers. The phosphates amount to about 6,000 tons. Now, good guano, as it reaches the farmer, contains, on an average, about 16 per cent. of ammonia; and 4 cwt., or 450 lbs., of such guano per acre, would be considered a rich average dressing, and would contain 72 lbs. of ammonia.

The ammoniacal matter in the sewage of the metropolis would supply that quantity to 320,000 acres, or 500 square miles. Now, this quantity of ammonia, if it could be entirely preserved, would represent, at the market price of £60 per ton, £600,000.

When the idea first fixed itself in my mind, that during my own lifetime thirty million pounds' worth of ammonia had thus gone to waste from the city of London alone, I felt that the utilisation of the sewage of towns had become a question of the highest financial importance; but I felt also that there is another question linked with it, of a much higher order—the sanitary precautions which must precede that utilisation, on which precautions the health and lives of the population are greatly dependent.

For, mark how improved sanitary arrangements, with deep drainage, and a rapid removal and purification of the sewage, and consequently of the river, have been associated, at Leicester, with a decrease in the number of deaths; a decrease amounting to 275 yearly, as shown by this return from the Board of Health:—

TABLE OF MORTALITY OF THE BOROUGH OF LEICESTER.

	First quarter.	Second quarter.	Half-yearly Total.	Third quarter.	Fourth quarter.	Half-yearly Total	Yearly Total.
1852	432	374	806	501	466	967	1,773
1853	448	348	796	404	480	884	1,680
1854	420	421	841	399	340	739	1,580
1855	450	366	816	344	348	692	1,498
1856	340	324	664	355	—	—	—

Deaths from Zymotic Disease.

1852—561
1853—371
1854—450
1855—232

Population in 1853—61,000
,, 1856—65,000

275 lives saved to the population of Leicester would be proportionate to 12,000 lives to the metropolitan population.

To aid in bringing about in London such a result as the spirited corporation of Leicester, by employing Mr. Wicksteed's plans and inventions, have effected in that borough, is an object worthy of any man's ambition; and the man who has devoted his engineering experience and inventive talents to so great a cause, can never look back, in future years, to the period of his life so occupied, or to his money so spent (whether with profit to himself or not) as time or money spent in vain, and such may justly be the reflections of Mr. Wicksteed.

There is but one feeling throughout England, as to the necessity of introducing every practicable sanitary regulation into our crowded towns, including an increased and improved supply of water, a deepening of the drainage, and a purifying of the streams from pollution. But all men are not so ready to admit that utilisation of our sewage should be part of such a system. "Away with it to the German ocean!" is the easier solution of the question.

I fear also there is even a stronger and more general feeling against the process of deodorising, and the manufacture of manure from the sewage; but I believe this feeling arises chiefly from the subject being taken in a wrong point of view. I must beg you will strive to banish foregone conclusions from your minds when listening to the statement I am about to make.

I am not going to describe solid sewage as an English guano, worth £4 or £5 per ton, but as a substance containing ingredients especially valuable on heavy soils, and available near the place of its production. I shall show that it can be made at three or four shillings per ton, and that it is likely to realise a rather larger sum in the market under judicious arrangements. It must be remembered that the great mass of farmers do not look alone to manures rich in nitrogenous matters. Lime, chalk, marl, seaweed, road scrapings, old mortar, cinders, and even clay, are paid for, and carted sometimes many miles during the less busy season of the year; and sewage manure will also find purchasers, at a low price, where it can be obtained at a short and cheap carriage. In this respect solid sewage works in London would be admirably situated, commanding by the river a water carriage on a tidal stream both up and down its course, in conjunction with several canals, offering great facilities for barging to convenient depôts. Solid sewage, though it may contain only 1 per cent. of ammonia, would be valuable on some soils from the earthy matters held in it, in an extremely divided state. Its composition, however, is very variable, and the analyses that have been published have been too often made from the dry lump, after long exposure to the air, and are so far fallacious.

Sewage contains the debris of every description of animal and vegetable matter, mixed with some valuable mineral substances. The refuse from our abodes, unquestionably forms the greater and more valuable portion. Man does not, like our farmyard animals, which fatten in a few weeks or months, carry off or retain much of the nourishment he consumes; his food is chiefly employed in renewing and not in increasing his frame. Every kitchen sink also supplies a large quantity of animal refuse, or waste. Each falling shower washes into the sewers impurities of the air, quantities of soot, finely triturated mineral matters, as well as potash from the decomposed granite of the streets. Manufactories add many other substances to the foregoing, and tons of soap increase the richness of the stream.

These miscellaneous matters, dissolved and broken down in the waste water, unite to form the sewage of London, which, unless stained by some bright coloured dye, generally offers a nearly uniform blackish grey mixture. Very little solid matter, except chips or shavings of wood, or feathers, ever make their appearance.

This sewage, then, contains a vast variety of ingredients, the most valuable being held in solution, and in the state most favourable for assimilation by vegetables, among others, a fair proportion of nitrogenous matter. But plants do not live principally upon nitrogenized food, not even those which most abound with it when harvested. Who ever thinks of giving his clover a nitrogenized manure? Gypsum, or ashes, are the most energetic stimulants to the growth of clover. Yet a crop of clover contains three times as much nitrogen as a crop of wheat. Give clover only a crop of sulphate of lime, and it will find its own nitrogen from the ammonia in the air, or in the soil. Again, the clover plant, after carrying off with it so large a quantity of nitrogen, is one of the best preparers for a crop of wheat, which delights in nitrogenous manures.

Solid sewage manure, therefore, should not be valued solely by the nitrogen it contains—nevertheless, it contains more nitrogenous matter than farmyard manure—besides, many other substances, which roots can seize upon during the gradual progress of decomposition; in fact, there is not a particle of matter which floats away in the sewage of this great city that may not one

day enter as a component part into the vegetable system. Nothing therein would be wasted by nature, though so recklessly disregarded by man; useless, indeed, worse than useless to him, till vegetation has, by its re-constructive power, again organised, in the growth of its own structure (the future food of a higher order in creation), that very refuse, which animal life, having previously derived from the same vegetable source, had afterwards rejected as useless or effete.

The vegetable kingdom, placed by the Creator in the beginning, on the confines of vital existence, as the inanimate purveyor for animate life, is the true Phœnix, which springs a-fresh with ever-renewed vigour from the ashes of decay.

The fetid stream with which we have long wantonly polluted our noble river, and are now so anxious to pour wastefully into the ocean, carrying with it the disorganised fabric of the richest products from every varied agricultural district of the world, would, under wiser and more provident treatment, restore through the intervention of vegetable life in the succeeding year a bounteous supply of the bread "the staff of life" to the cottage of the poor, and "every luxury of the season" to the mansion of the rich.

The magic words that shall bring about this magical result are—

IRRIGATION AND DEODORIZATION.

Deodorisation, in its practical sense, does not simply mean the removal of offensive smell, but the purification of the water by the abstraction of all extraneous matter, 800 or 1,200 tons of water only furnishing one ton of solid dry residuum.

If this deposit is to be utilised, it must contain the salts, and especially the ammoniacal salts, with the undecomposed nitrogenous matter, but if the fluid part is to be employed for irrigation, then the suspended matters alone should be separated, leaving the more valuable salts in solution.

We now arrive at the question, what is the cost of production of this heterogeneous compound? I will give the answer for a population of 500,000.

		Per Annum.
Buildings and machinery, consisting of the lime pits, reservoirs, Jacob's ladders, and filters, £40,000, at £4 per cent.		£1,600
6 lime men, at 20s. per week...	£6	
15 filter men ,, ,, ,, ...	15	
6 lads at 10s. ,, ,, ...	3	
2 reservoir men at 20s. ,, ...	2	
29 hands Total...	£26	1,352
Wear and tear and stores		473
100 tons lime per week, at 12s. 6d.		3,250
Engine-power, hired from the pumping-engine		325
Total		£7,000

The make of deposit from the filters will be 60,000 tons per annum in a plastic state, like clay ready for brickmaking, the cost being 2s. 4d. per ton, including the discharge into carts or barges lying alongside the works.

The cost of removal I have not thought it necessary to include, as it may be set against the clearing out of the proposed reservoirs on the Thames.

The cost of pumping is greatly in favour of the deodorising plan. Mr. Bazalgette shows, in his report, that the engine-power for the western district will be reduced by deodorising at Kensington from £15,120 to £8,900 per annum. The above calculations are made upon the supposition that the whole of the sewage is deodorized and solidified in the outskirts of the metropolis. If, however, it were determined to combine deodorizing with irrigation, this portion of the expense would be much diminished, whilst the make would be nearly the same.

To effect the double object, the effluent stream on its course to the river would have to be conveyed through such an extent of the comparatively level county of Essex as could consume the water for irrigation.

Supposing the season to be favourable for irrigation, and the whole of the water to be required at any particular time by the farmers, the sewage would be treated with a greatly reduced charge of lime, only just sufficient to fix the sulphur, and precipitate the coarser and more putrifiable matters in suspension, allowing the salts in solution to pass off with the still turbid but deodorized water in such a state that the whole would sink into the soil without leaving a putrifying scum on the surface.

When a reduced quantity of irrigating water was needed, it would be passed down during a sufficient number of hours only to meet the demand, and at those hours when experience would have shown that the fertilising salts were most abundant in the sewage.

Such an arrangement might be facilitated by a simple line of telegraph between the sluice-keepers and the London works. By this combined system none of the sewage would ever run to waste, infect the atmosphere, or pollute the Thames at any part of its course. I shall presently have occasion to allude to a recommendation of the engineer of the Board of Works for the establishment of a deodorizing station near Kensington for the Middlesex sewage. Should that recommendation be hereafter adopted it is obvious that the land owners in the western district would enjoy every facility for enriching their own land by irrigation with their own sewage, instead of absurdly sending the sewage on a long journey through the metropolis to the Essex farmers at a cost of £12,000 per annum. The proposed system of metropolitan drainage does not provide for the sewage of Isleworth, Brentford, or Acton, which will continue to pollute the river above the bridges. The cure for the evil is obvious, namely, local deodorizing works at Brentford.

Before I attempt to explain the treatment to which I would suggest that the metropolitan sewage should be subjected, I will give a brief sketch of the new drainage plans for the metropolis, and the present state of that vexed question as it now fluctuates between the Metropolitan Board, and the chief Commissioner of her Majesty's Board of Works. And first, let me call your attention to the more serious evils of the present state of the sewerage of London. The Thames has ever been the grand arterial sewer of London; into it the drains of the whole metropolis flow at numerous places and at various levels. On either side of the river there is a considerable extent of low land, and the houses closely built upon it have their basements so much below the level of high water that the sewers beneath them can only discharge their contents for about four hours in every twelve, when the tide is lowest. The sewers are closed at their outlets during the rest of the day, by floodgates which prevent the river water flowing up and submerging the cellars of the houses, and are thus converted into cesspools under the streets, in direct communication with the houses built over them, where the sewage accumulates, stagnates, and putrifies.

Sewage, so detained in its passage to an outfall, becomes far more offensive than that which can flow off uninterruptedly, and any new system should obviate entirely this serious objection to the present mode of draining.

Beyond the low districts above described, the ground rises more or less in various places, and the sewage, produced by the population which covers these upper parts of the metropolis, might have been taken to the river at a level high enough to enable it to flow off at all periods of the tide. But this has not been done; the sewage is merely conducted to some near drain in the low district and subjected to the same inconvenience of being tide-locked, adding to the fetid mass for sixteen hours in the twenty-four.

But this is not all. The rain water which falls upon

all the districts, both high and low, also descends into the low sewers, and as these are not of sufficient capacity to store the sudden influx of storm-water, in addition to the sewage already stagnating in them, whenever a heavy storm occurs they become overcharged, and in such cases the putrid sewage floods and destroys much valuable property, leaving entire streets unhealthy and damp for many days after.

Such is the present state of our London drainage and its main objections.

The cure of the evil is to be accomplished—

I. By an unintermitting flow in the sewers of those parts of London whose subsoil is below the level of high water, and this can only be effected by pumping up the contents of the drains to a level above high tide, in order to overcome, artificially, the natural disadvantages of these low districts. This is technically called providing the drainage with an artificial outfall, a mode of overcoming the difficulty of draining a flat district, first proposed by Mr. Wicksteed, for the city of Berlin, in 1841, and tantamount as described by Sir William Cubitt and Mr. Stephenson, in their report on the 17th of October, 1853, to raising the level of this low district twenty feet, and entirely overcoming the natural disadvantages of its situation.

II. The sewage of the upper districts must be intercepted and conducted to a natural outfall by gravitation *before putrefaction commences.*

III. The sewage conduits must have no communication with the houses or the outer air; the discharge must not prove a focus of infection and pestilence, and the Thames must no longer be a cesspool for the sewers of London. At present, with each rise and fall of the tide, the accumulated contamination of more than fifty days oscillates up and down the stream between Gravesend and Richmond.

The outfall of the sewage is, therefore, the pivot point of the entire system to which the local drainage is subsidiary. On this all-important point Mr. Stephenson and Sir William Cubitt reported their views, founded upon a series of experiments made by the late Mr. Frank Forster, the main object of which was to determine how near to London the sewage could be discharged into the river, without finding its way back again to the inhabited parts of the town. The experiments proved that it was essential to go at least as far as Barking Creek, and discharge the sewage at or near high water. For the delivery of the sewage into the river at high water is equivalent to its discharge at low water, at a point twelve miles lower down the river; therefore the construction of twelve miles of sewer is saved, by discharging the sewage at high, instead of low water.

I will now point out on this large plan the works proposed for the south side of the Thames. The low level sewer provides for a district of twenty-two square miles. This sewer commences at Putney, and is carried by Wandsworth, Battersea, and Kennington, to the pumping station on a piece of waste land on the east bank of Deptford Creek. The total length of this sewer is nine miles. The high level sewer is designed to intercept the sewage of fourteen square miles by gravitation. It commences at Clapham Common, passing by Brixton, Camberwell, and Peckham, and along the Greenwich road to the Deptford pumping station. Here the sewage of the "low-level sewer" is pumped up twenty and a half feet into it by engines of 520 horse-power. From Deptford Creek the united streams flow by gravitation to Woolwich, and thence through the marshes to Erith Reach.

To contain the sewage till discharged into the centre and bottom of the river, near the time of high water, a covered reservoir of 4½ acres is to be constructed, capable of containing 1,000,000 cubic feet of sewage.

We will now pass over to the north side of the Thames. The entire area north of the Thames, from which it is proposed to intercept the sewage, comprises about sixty square miles. For this area it is proposed to construct four main lines of intercepting sewers, forming four separate drainage areas, viz., the northern high level, and the middle level areas, from which the sewage would be conveyed by gravitation; the low level area, from which the sewage would be pumped into the high level outfall, common to the three areas, and the western area, for which two alternative propositions were laid by Mr. Bazalgette before the Metropolitan Board; the one which he recommended for economy, and as averting serious engineering difficulties, was the employment of deodorizing works near the mouth of the Kensington canal; the other proposition, which he seems to have given reluctantly as a pis-aller, costly and difficult of execution, inconvenient to traffic, and monstrous in its disregard to the health of the most populous part of London, *was to carry the sewage of the whole twenty-two square miles of the western district into and through the chief thoroughfares of the cities of Westminster and London*, because the deodorization of the sewage *was locally objected to.*

The northern high level area includes about ten square miles. The sewer commences at the foot of Hampstead-hill, and passing through Holloway, Hackney, and Victoria-park, to the river Lea, over which it is carried by an aqueduct. The middle level area includes about seventeen square miles, commences at Kensal Green, and passes through Notting-hill, Oxford-street, Clerkenwell, and Bethnal Green, and effects a junction with the former sewer, with which it will be carried over the river Lea to a reservoir, and thence discharged into the Thames at high water. The low level area includes about eleven square miles. The levels are so low that the aid of pumping is necessary to produce efficient drainage.

The low level sewer commences in Chelsea, passes along Parliament-street, by Whitehall, to Charing-cross, the Strand, and Fleet-street, to New Bridge-street, where it intercepts the Fleet sewer, Cannon-street, King William-street, thence through Eastcheap, Tower-hill, and Limehouse, passes under the River Lea, to a pumping-station near the Abbey-mills. There the sewage will be lifted about 37 feet to the high level sewers.

Mr. Bazalgette, in this part of his report, takes an opportunity of reiterating a recommendation which he, in conjunction with Mr. Hayward, had made two years before. He says, that the low level sewer should be constructed as near the Thames as practicable, both to avoid the public inconvenience along crowded streets during construction, and to intercept the sewage close to the existing outlets.

Should the long-contemplated embankment of the Thames between Westminster and London-bridge be carried out, much of the cost and difficulty of a river line of sewer would be obviated, and the intercepting sewer might be most advantageously constructed in conjunction with the embankment between Hungerford and London bridges.

The main difficulties and the greatest inconvenience would occur along the Strand, Fleet-street, and eastwards; and this route involves the necessity for *reconstructing and reversing the direction of all the branch sewers on the south of the line.*

The ultimate object is the purification of the Thames. *That object cannot be obtained until the channel of the river is deepened, its scouring-power increased, and its mud banks removed by the construction of a proper embankment in conjunction with the scheme of interception.*

Mr. Bazalgette adds,—I beg to state, *that a large amount of risk and capital may be saved, by executing this sewer in conjunction with an embankment along the north bank of the Thames, and that the execution of both these works is essential to the full attainment of the object desired.*

This is not the opinion of the metropolitan engineer alone, but of many of the most experienced engineers in the country; yet this urgent recommendation is passed by, and the fetid mud-banks of the Thames are likely to continue a disgrace—unparalleled by any city on the Con-

tinent—a dire disgrace to London, the metropolis of the world. Mr. Bazalgette's voice, however, may not have been raised in vain. The Chief Commissioner has declared that the drainage plans are still to be submitted to the ablest engineers in the country, when Mr. Bazalgette's views may yet find support.

The western district contains about twenty-one miles. The surface is low, much of it being but slightly above high-water mark. Mr. Bazalgette reports,—"In 1854, Mr. Haywood and I recommended for this area, mainly on the score of economy, works for purifying its sewage waters, and then discharging them into the Thames," —instead of conveying the sewage of 21 square miles through the heart of Westminster and London to the Lea. He adds,—"Since then, extensive experiments, which have been made in several places, all tend to confirm the statement, that sewage matter can be separated from the water in which it is dissolved without creating a nuisance, and the water may, by this means, be rendered clean and inoffensive.

"Thus it was that, in the year 1854, we were induced to recommend the construction of sewage works in a suburban locality, removed from houses, viz., in the fields on the banks of the river west of Kensington canal.

"In making that recommendation we assumed the sewage to be valueless; but we had ascertained that the cost of the process of purification would be very much less than that of conveying the sewage to high water at Barking Creek. And this latter circumstance mainly influenced us, although *the increased engineering difficulties attendant on the other scheme* had some share in forming our decision.

"Since the date of that report objections have been raised to the establishment of deodorising works in the locality mentioned."

Whichever plan be adopted, it is proposed to make the western sewer capable of being ultimately extended to Brentford. The sewage of that and of other populous towns in the neighbourhood will, in the mean time, continue to pour their sewage into the Thames above the bridges.

"Supposing the sewage of the western district to be conveyed to deodorising works near the mouth of the Kensington canal, a branch from Chelsea hospital would have to be constructed."

The sewage would be raised by pumping either into the low level sewer, or to the sewage works.

"If it is decided to deal with the sewage locally at the sewage works, it would be raised at the Kensington canal fifteen and a half feet, requiring 153 horse-power. But, if conveyed to the out-fall, it would have to be raised twenty and a half feet, requiring for that purpose 328 horse-power. The cost of pumping, in the latter case, would amount to £15,120 per annum, but only to £8,900 per annum if the sewage were deodorised near Kensington canal.

"The saving effected by not conveying the sewage to the outfall, together with the diminution of engine-power, would amount to £8,059 per annum, advantages which induced me still to recommend the cheaper process. Should the sewage at some future time attain a marketable value, it would go toward liquidating the expenses of extracting it from the water."

The saving on the further extension to Erith Reach will again increase this amount, which, together with the reduced cost of the deodorising process, would now amount to a saving of £12,000 a year on the western district alone, and this may one day be further increased by the sale of the manure.

Having quoted from Mr. Bazalgette's earlier reports his repeated recommendation of the deodorising system for the western district, let me now read an extract from a much later report, dated the 25th September last, after Sir Benjamin Hall had twice rejected, on behalf of the Government, outfalls approved by the Metropolitan Board. He says:—"The approved drainage scheme is capable of being adapted to a variety of outfalls into the Thames, or to the utilisation of the sewage at Barking Creek and Woolwich Marshes, *or even nearer to London, and the Thames thus purified at a less cost*, the reservoirs at those places being dispensed with, substituting for them deodorising works, and discharging the purified waters into the Thames at all times of the tide."

"This process would entirely remove the sewage from the river in a practical point of view. *A further saving of nearly half a million might be effected by terminating the sewers and establishing deodorising works nearer to London*, say in the Greenwich Marshes and the West Ham Marshes, which would accomplish the object desired without creating a nuisance."

Now let us examine whether the deodorisation cannot be better performed elsewhere. Taking first the western district, I will give an outline of the deodorising works as they would be established near the outlet of the Kensington Conal.

1st. The pumping engines would be of a less power than that requisite to raise the sewage into the low-level sewer opposite Vauxhall.

2nd. The deodorising canals, the elevators, and filter frames, would be entirely built in; so that the solid deposit would be discharged direct from the filters into covered barges, without any previous contact with the outer air, and be at once conveyed to depôts on the banks of the river, far beyond the limits of the metropolis.

3rd. Were it decided to flush or scour during dry weather the low-level sewer, passing along the Strand and Fleet-street line, with the effluent water, one deposit canal alone would be employed. But should it be found preferable to discharge it into the river, a second canal, two hundred feet in length, would be necessary; and after passing through it, the effluent stream would be found transparent, and free from taste and smell. The next point at which deodorising works might be introduced is near the river Lea.

The position of these works ought unquestionably to be on the City side of the Lea, the passage over which river, by a tubular aqueduct for the high level, and by a conduit beneath the river bed for the low level sewer, will be extremely costly and difficult of execution.

The expensive extension and the huge reservoir in the marshes would be entirely dispensed with.

The deodorising system might also be applied to the southern drainage scheme by works at Deptford Creek, the pumping-station there proposed being most conveniently situated for the purpose. The necessity would thus be avoided of conveying the sewage from Clapham and Putney to the reservoirs in the marshes, and the sewage of Greenwich might be brought down by its natural fall to the Deptford works, just as the Chelsea sewage was to the western works at Kensington canal, leaving the sewage of Woolwich and the lower part of the line to be treated separately, if at all.

I will now give the estimate of cost for the drainage and conveyance of the sewage down to Erith Reach, as now under the consideration of the Metropolitan Board, and compare it with the same drainage modified by deodorizing works. (See Table in following page.)

Hitherto I have confined myself to showing how easily the system which Mr. Bazalgette himself recommends at the Kensington canal, for an area of twenty-two square miles may be extended to every other part of the remaining eighty square miles of his projected plan. But if I have succeeded in imparting to my hearers a small share of the conviction I myself derive from the success of the Leicester works, and have satisfactorily shown that deodorizing works can be placed, even in the most densely crowded localities, without the possibility of any well-grounded objection being raised against them, it may be asked, whether considerable advantage would not accrue from augmenting their number; and whether, by placing them in the centres rather than at the extremities of the lines of intercepting sewers the consequent diminution of distance,

COMPARATIVE ESTIMATE OF CAPITAL AND WORKING EXPENSES.

Detail of Works adopted by Metropolitan Board of Works.	Estimate by Mr. Bazalgette for conveying sewage to Erith Reach.	Cost of the same drainage with deodorising works.
SOUTH SIDE.		
High level sewer from Clapham to Deptford and branch	£199,226	£199,226
Low level sewer from Putney to Deptford and branch	209,000	209,000
Extension from Deptford to Plumstead	155,550	77,775
Reservoir and land for pumping station	103,140	Land below.
Engine-houses, engines, pumps, &c.	164,780	91,980
(*One pumping saved by deodorising.*)		
NORTH SIDE.		
High level sewer	129,500	129,500
Middle level sewer and branch	214,200	214,200
Low level sewer, exclusive of the sewer from Western District	253,800	253,800
Western District	78,200	78,200
Main outfall sewer to Barking, reservoir and land	425,800	Land below.
Engine-houses, engines, pumps, &c.	112,000	112,000
Additional cost of conveying sewage from Western District to Barking	348,180	—
Extensions to Erith Reach	443,224	—
Latest estimate—dated Dec. 1, 1856	£2,836,600	£1,365,681
Land, 50 acres at £300		15,000
Deodorizing Works		250,000
Passage over and under the Lea River	?	
Brentford and Acton Extension	?	
	£2,836,600	£1,630,681
Saving in Capital		£1,205,919.

ANNUAL WORKING EXPENSES.

Mr. Bazalgette's Estimate adopted by the Board		£28,330
DEODORIZING WORKING EXPENSES.		
WEEKLY.		
30 Lime Mixers, at 20s.	£30	
75 Filter Press Men, at 20s.	75	
30 Filter Press Lads, at 10s.	15	
10 Reservoir Men, at 20s.	10	
Wages	£130	
Weeks	52	
Wages per Annum	£6,760	
Three Superintendents at £150	450	
Wear and Tear	2,365	
Lime, 26,000 tons, at 12s. 6d.	16,250	
Engine Power rented from Pumping Engines	1,625	
		£27,450

Produce from filter presses, 300,000 tons annually, which, if sold at only 2s. per ton, would cover the working expenses.

£1,205,919, then, would appear to be the amount of capital to be saved by adopting the deodorising system over the whole of the metropolitan drainage scheme; and I will not shrink from comparing my portion of the estimates, step by step, with those adopted by the Board. As far as I can separate the amounts representing the cost of drainage, &c., for the western district alone, they stand thus:—

		IF DEODORISED.
Metropolitan estimates for drainage	£78,000	£78,000
Additional cost of conveying sewage from western district to Barking alone	348,180	
On to Erith (*cost unknown*)		
Deodorising works at the Kensington canal (Population 151,950)		21,000
	£426,180	£99,000

to which the sewage would be conveyed, might not enable their size to be reduced, and their inclination to be increased, so as to ensure more perfect scouring. I have already said how heartily I concur in all Mr. Bazalgette has urged in reference to the Thames embankment, and the impossibility of ever arriving at the complete purification of the river, or at a wholesome and respectable state of its shores, unless that very necessary undertaking be carried out. I go further, and maintain that the embankment itself should enclose the deodorizing canals, the vaulted roofs of which would form a platform available for roads or any other purpose.

The embankment, in fact, is a key to the whole position. It will cut off the communication between the present sewers and the river, and, at the same time, furnish, without disturbing the streets, not only a site for deodorizing the sewage waters, but the best site, namely, one at or near the present mouths of the sewers, whilst the works would offer no interference to the roads, quays, or warehouses erected over them.

The capital required to carry out any system for unprofitably conveying the sewage of the metropolis down the river, would, in conjunction with the funds produced by the new wharves and docks, suffice to effect this great undertaking Until the embankment was considerably advanced, the sewers entering the Thames between London and Westminster Bridges would continue as now to pour their filth into the river, but all the enormous sewers above and below the bridges might at once be purified by the erection of local works which could be brought into operation within six months from the time at which the ground was placed in the hands of engineers. How many years must otherwise elapse before any portion of the metropolitan sewage will be directed from its present course.

One striking advantage in treating the sewage locally is, *the facility which it offers for meeting, at any future time, the necessities of an increasing population in any particular district.* On Mr. Bazalgette's plan, preparation is to be made *at once*, at an enormous increase of expense, for an addition of one million to the present population, an estimate which never may be realised, or at least not in the quarters anticipated.

Nothing that I have proposed would interfere with the high and middle level intercepting sewers, works comparatively inexpensive, and offering no engineering difficulties. I would only observe, that the sewage conveyed by those sewers should be treated locally, and the purified water, when needed, supplied during dry weather to the flushing of the lower and less rapid system of sewers.

Although several members of the Metropolitan Boards have visited the works at Leicester for their individual satisfaction, the authorities of the metropolis have not attempted to acquaint themselves on better ground than hearsay evidence, with the facts which have resulted from the Leicester experiment. It is a reproach to all parties that no official knowledge is possessed upon a subject which is associated at Leicester with such changes in the Bills of Mortality, as are exhibited by the report of the Officer of Health.

High scientific opinions are not wanting in support of the system. I will read the following letter in proof of what I state:—

"Chemical Laboratory, Guy's Hospital,
September, 15th, 1851.

"SIR,—We have read with great attention your pamphlet, describing the patent process for producing solid manure from sewage water, and think that the plan which you proposed for collecting the sewage of towns and speedily converting it to a profitable and useful manure, excellent.

"The chemistry is properly explained, and the descriptions clear and intelligible.

"We can state of our knowledge, and from our own *experiments*, that by your process the nitrogenous organic matter, as well as the phosphoric acids, dissolved or undissolved, would go down and be retained in the solid deposit; while the water, after the precipitation is completed, will be discharged in a limpid state, and free from the offensive matter which it previously contained.

"The avoidance in your process of long exposure to the air, and the absence of artificial heat, ensures the separation, in the best manner, to prevent loss of the fertilising matters contained in the sewage water.

"We consider your process has, in fact, these advantages

over every other plan which has been proposed—it provides for the immediate and rapid sewerage of a district at all periods; it prevents the contamination of a river, or other sources of water supply by removing all noxious animal and vegetable matters; it provides for a speedy deodorisation, separation, and drying, of the solid and useful parts of the sewage; and, lastly, it furnishes to the agriculturist a cheap and useful manure.

"Wishing you success in a practical form,

"We are, yours, very truly,

"ARTHUR AIKIN. F.L.S.

"ALFRED S. TAYLOR, M.D., F.R.S.

"Professors of Chemistry, in Guy's Hospital."

"T. Wicksteed, Esq., &c., &c."

With such opinions and results in favour of the system, I demand, on public grounds, that further inquiry be made into the facts which I have alleged. Let chemists be appointed by the Government to analyse the sewage water at every stage of the operation; let a commission be appointed to visit and examine deliberately and frequently the works at Leicester, at all hours, and judge whether the results herein stated have been exaggerated, and if they are found to be fully borne out, let not the provisions of the act of 1855 be tortured into preventing the admission of limpid water into the Thames, when no objection has hitherto been raised to the discharge into the river of storm waters, which after passing for miles in common sewers cannot be remarkably pure and inodorous.

That ordinary sewage has high manuring properties is universally admitted, and I have shown how it may be employed, both economically and without contaminating the atmosphere. Again, the cheap manure in which the deposit can be produced in a solid form, yet promises to render its manufacture self-paying if not even lucrative. For my own part, I think that ultimately such will be the case. But farmers are slow in appreciating the value of any manure that does not possess strong fertilizing properties, and the quantity produced must for a time exceed the demand. Its value, however, for compost or "nitre beds" is beginning to be appreciated, which alone will open a wide field for its employment. Above a thousand tons have been taken by the farmers near Leicester during the past week, and further applications have been made, but at a very low price. Leaving the question of marketable value, my object this evening has been to represent the great facitities for, and advantages in, deodorizing the sewage water of the metropolis before putrescence is in full activity, and the restoration of the water either in a pure state to the river, or the use of it after deodorization for the purposes of inoffensive irrigation. That the sewage water can be sufficiently deodorized and purified by lime alone without causing the slightest nuisance, is a great fact, and I can see nothing but prejudice or penuriousness that can prevent its adoption.

DISCUSSION.

The CHAIRMAN said it was now his duty to invite discussion upon this subject. At the present stage he would only say that he agreed with the author of the paper in the importance of the question being solved as to the beneficial application of the sewage of the metropolis, and the prevention of its entire waste. When they recollected that the whole system of vegetable and animal life depended one upon the other—that vegetables lived upon carbonic acid, water, ammonia, and certain mineral substances—that these afforded food to animals during life, and were again resolved, by the effete matter during life and decay after death, into the same substances, viz., carbonic acid, water, and ammonia, it was not, he thought, a wise policy on the part of the metropolis to send away all that matter to feed sea-gulls and sea-lions, in order that it might be brought back again from Ichaboe in the form of guano. Instead of this general and wasteful distribution of our treasures throughout the world, it would be far better to use them economically and productively at home. He would mention one philosophical fact. The effete matter of a population was of all things just the thing to supply as manure for the growth of the food of that population. The Irish fed very much upon potatoes, and potatoes grew well in Ireland, because the effete matter of the potato feeder was exactly suited for the growth of that crop; and, in like manner, the population of the metropolis of this country would be best provided with food suited to it by the application of the sewage of the metropolis to the land. The 12,000 tons of nitrogen consumed in the food of its inhabitants was capable of being applied to the growth of a similar representative of food if we followed Nature's teachings. He was in the first instance surprised at the statement that the inhabitants of London, in maintaining their vitality, consumed about 12,000 tons of nitrogen annually: but, ignorant of the mode of arriving at this result by Mr. Cooke, he had made the calculation on his own data, and came to the result of 11,768 tons, which was very near the amount stated in the paper.

Mr. J. B. LAWES said, that he read before this Society, about two years ago, a paper upon the sewage of London, in which he expressed an opinion that it would not be possible, by any process hitherto discovered, to manufacture a solid manure from sewage, which should be remunerative both to the manufacturer and to the agriculturist. This subject was very fully entered into at that time. Indeed, the interest taken in it was so great, that the Council of the Society was kind enough to devote an extra night to the discussion. Mr. Wicksteed's pamphlet was then before the public, in which he endeavoured to show that a profit of 22 per cent. could be obtained upon a capital of one million, by applying to the sewage of London that process which had since been carried out at Leicester, and described this evening by Mr. Cooke. Mr. Wicksteed considered that his solid manure would sell for £2 to £2 13s. 0d. per ton. It was, however, argued by him (Mr. Lawes) and others, that the chemical composition of the manure would not justify Mr. Wicksteed in assigning to it a greater value than a few shillings per ton. It must be gratifying to those who, like him (Mr. Lawes), considered that the value of any manure could be determined by its chemical composition, to find that this opinion had been confirmed that night by Mr. Cooke. This sewage deposit was no longer a valuable artificial manure, but it was to be ranked with lime, chalk, clay, &c. Mr. Cooke had said, "that it would find purchasers at a low price, when it could be obtained at an easy and short carriage; and that, by judicious arrangements, it might sell for rather more than it costs." The great objection to Mr. Wicksteed's process was this, that while increasing the sewage by an enormous bulk of worthless matter, it failed to arrest the greater portion of that which was most valuable in the sewage, which, consequently, flowed back into the sewers or rivers. It was well known to chemists that lime would not precipitate ammonia or its salts from a liquid containing them. Mr. Cooke endeavoured to meet the objection by saying, that in using Mr. Wicksteed's process they did not deal with highly putrescent sewage abounding in ammonia. Professor Way, however, held a different opinion; he examined sewer-water from places in the centre of London, from Barret-court and Dorset-square, and stated that all the nitrogen in the liquid state seemed to be in the form of ammoniacal salts; that in one case 84 per cent., and in the other 89 per cent. of the whole ammonia in the sewage existed in the soluble state. While, therefore, he (Mr. Lawes) might lament, with Mr. Cooke, that thirty million pounds worth of ammonia had gone to waste in the City of London during his life, he (Mr. Lawes) could not admit that this waste would be stopped by the application of Mr. Wicksteed's process. Mr. Cooke had, perhaps wisely, abstained from furnishing an analysis of his manure, but he (Mr. Lawes) would, however, venture to quote one which had lately been given him by Professor Voelcker, Professor of Chemistry to the Royal Agricultural College, Cirencester:—

Analysis of Leicester bricks made from the sewage of the town of Leicester, by Mr. Wicksteed's Lime process.

Water	10·52
Organic matters	12·46
Oxides of iron and alumina	2·89
Phosphate of Lime (bone earth)	2·27
Carbonate of Lime	52·99
Sulphate of Lime	1·76
Carbonate of magnesia	3·67
Potash	0·26
Chloride of Sodium	0·45
Insoluble siliceous matter	13·50
	100·77

And containing nitrogen equal to 0·60; ammonia, 0·72.

Now, here was a substance containing 80 per cent. of matter to which it was impossible to assign any money value, and containing not more than 16 or 17 lbs. of ammonia in a ton. What could be done with 300,000 tons of this substance, the annual amount which would be produced if Mr. Wicksteed's process was applied to the London sewage? It certainly could not be sold, and it was doubtful whether it would be taken as a gift. He (Mr. Lawes) could hardly think that the Chief Commissioner of Public Works would consider himself justified in permitting deodorising works to be erected in the metropolis, from which 8 or 9-tenths of the ammonia in the sewage operated upon would flow back into the sewers or river, more especially as ammonia was the element which, more than any other, was supposed to be the vehicle of miasma and contagion. He (Mr. Lawes) considered that the proper mothod of using sewage was by irrigation. If, however, it was found impossible to select any district upon which the fluid could be deposited, he was disposed to join in the cry of those who say, away with the sewage to the German ocean.

Mr. E. CHADWICK, C.B., said that, on the statement made by Mr. Cooke, that "it behoved the authorities generally to consider whether the effluvium from an extensive area saturated with sewage, poisoning the atmosphere by putrifying and steaming during the heat of the summer, might not be as injurious to the health of Kent, aye, to the metropolis itself, as the most efficient subterranean removal of sewage might be beneficial," it was to be observed that by one set of authorities, at the least, the foundation of such apprehensions had been carefully examined, and provisions made to meet them; and it was, doubtless, the duty of those who had the responsibility of new works to re-investigate the subject, and to examine the works in actual operation. The first scheme for applying the sewage of the metropolis to other towns was proposed by the late Mr. Smith, of Deanston, and was simply an application of the practice at Edinburgh of applying it by submersion. The result of the investigation of the Board of Health was to establish sanitary objections to this system, as well as objections of an agricultural and economical nature. The deodorising power of soils might be illustrated by such common facts as that, when the cook had an "oniony" knife, it was the practice to put it in garden mould, where it was soon perfectly deodorised. But by Professor Way, and by Mr. Huxtable, those deodorising powers of the soils had been demonstrated scientifically and experimentally, by passing sewage, or mixtures of decomposing animal or vegetable matter, through a sufficient stratum. Most persons who lived in the neighbourhood of the parks, at the period of top-dressings, had been annoyed by the foul odours arising from this operation. Indeed, he had known frequent illness occasioned by them. Similar evils were at times experienced during the heavy dunging and top-dressings of market-gardens with decomposing animal manures. Great loss also ensued; agriculturists agreed that two-thirds, or three-fourths, escaped in a gaseous form. The mode of preventing this loss and nuisance was not to apply chemicals, but simply to perform the work of disintegration at once by putting the solid manure into water to arrest the gases, and applying it by the water-cart or by steam-power. This process was in fact a saving one. Mr. Beach, a market gardener, at Isleworth, had given proof, in prize fruit and vegetation, of its special advantages. The application of those principles to the disposal of the refuse of towns in the prevention of nuisances, was now proved in a sufficient number of instances. It had been done at Rugby now for three years. In respect to the drainage, it was to be observed, that those who only knew sewage under the old conditions, as decomposing manure from the overflow of cesspools or house drains, where it had been detained for weeks, months, or years, were unaware of the new conditions of town drainage, in which all cesspools were abolished, self-cleansing tubular house drains and sewers being substituted, and the refuse removed at once, before it could become decomposed. At Rugby, all refuse was immediately removed by the new self-cleansing drainage and sewers, and afterwards distributed by steam-power on the principle of the water-cart. The results of the working were in complete accordance with the principles and facts to which he had adverted. The sewage was at once received in the soil, and held there, not merely in mechanical suspension, but in chemical combination, until it was taken up by vegetation. The effect was shown in the pellucid and usually inodorous condition in which the surplus water ran away on days when there was no rainfall. The sanitary conditions and the agricultural conditions, were, as he (Mr. Chadwick) conceived, inseparable, and the instance cited would be found to demonstrate that where land was available, they might be satisfactorily established by this method. But, whilst it operated to arrest decomposition, and deodorize the refuse of towns, and to prevent a nuisance, by a speaker at the Great Metropolitan Board of Works, and in writings of persons advocating particular interests, this very case had been held forth as an instance of the creation of the nuisance. On this essential point he must claim to adduce the authentic declaration of Mr. Walker himself, made in April last, in a letter in answer to one of those writers. Mr. Chadwick then read a quotation from the letter. Besides the sanitary results demonstrated, this particular instance tended, in connexion with other evidence, to settle the extent of area required for the application of the sewage of a town population. At present the ordinary sewage derived there from a thousand houses, was directly applied to about five hundred acres, by pumping, without any storeage; and there was an end to sewer marshes, or sewer lakes; but it sufficed only for an average of three or four dressings during the year. Mr. Walker, though satisfied with the results as they were, was of opinion that the refuse might be absorbed on half the area; and it appeared that two hundred acres of ordinary drained land would suffice to utilize the sewage of one thousand houses. On such a scale the sewage of the whole of the metropolis might be utilized on an area of ten miles square. Where land was obtainable, and he confined his objection to such a case, the intervention of such a process as that proposed, was, he considered, an unnecessary expense, a waste of engineering work, of chemical matter, and a loss and deterioration of manure.

Mr. G. F. WILSON, F.R.S., said, having seen the works at Leicester in operation, he could bear testimony to the apparent perfection of the numerous mechanical arrangements there, and to the complete manner in which the sewage was deodorized and disinfected. The chemical part of the process was less complete; through the undecomposed nitrogenous matter, some compounds of urea, such as the oxalate and nitrate phosphates, soap suds, and some other good manure could be saved by the lime process, precipitation, and filtration, yet ammonia, when once formed, could not be so. He thought,

however, that in one chemical point of view the lecturer had not done Mr. Wicksteed's process justice; though lime would not fix ammonia, other bodies known to chemists would; and there was no doubt that greater chemical knowledge applied to the subject would introduce those bodies either in substitution for, or in addition to, the lime—magnesian limestone, for example. Now it seemed to him that Mr. Wicksteed's process and apparatus afforded the great present good of rendering sewage entirely innoxious and inoffensive; the further, though less important, present good, of separating a considerable portion of the fertilizing matter; and the great future good of supplying in operation a beautifully complete apparatus, with appliances for precipitation, for conveying out the precipitate, and its separation, by filtration, from the water with which it was mixed, all at once available when the body to fix the ammonia made its appearance. Now he (Mr. Wilson) could not think, even if the chemical knowledge would allow it (and we had now great scientific chemists) that the common sense of the country would not interfere to prevent any such monstrous plan as that by which the enormously valuable matter of the London sewers would be carried and allowed to run to waste into the German Ocean. If we waited until a combined mechanical and chemical process arrived at perfection, we should wait for ever. How did great manufactures rise? When a process had attained a moderate degree of perfection, it was put into operation; then improvements after improvements were naturally suggested. The great thing was to get a good practical starting point, and the meeting would, he thought, agree with him that Mr. Wicksteed had, at the very least, advanced thus far at Leicester.

Mr. S. SIDNEY said this was the third time that the value of sewage manure had been discussed by the Society of Arts. On the first occasion, he (Mr. Sidney) characterised as wild exaggerations the poetical view which Mr. Mechi took of the refuse of cities. On the second occasion, Mr. Bennet Lawes, in a most able paper, exhausted the chemical part of the question, and came to the conclusion, that a distant limited application of sewage manure to grass land in a liquid state, was its only profitable use; and now Mr. F. Cooke, in his very candid paper, was content to take manufactured solid sewage, at from 2s. to 4s. per ton, a price that would not bear the cost of carriage, as he (Mr. Sidney) had shown in former discussions. This theory of the enormous value of town sewage was not new. The late ingenious Mr. Smith, of Deanston, was the author of a theory, that town sewage could be converted into a source of revenue—a theory which the late Board of Health had employed, in order to bribe many towns to enter into costly and unprofitable schemes of town drainage. In 1848, Mr. Smith, of Deanston, in a report circulated under the authority of the Board of Health, wrote—"Assuming that 5 cwt. of sewer water is equal to 2½ cwt. of guano—that the sewer water of every town was worth £1 per head per annum (that would give three millions sterling for London); and that, therefore, 'such an income annually would provide a fund for the improvement of all towns in a manner corresponding with the most enlightened views with respect to sanitary regulations.'" A very little inquiry served to show, that while 2½ cwt. of guano was worth 30s., and would produce an increase of six bushels of wheat per acre over ordinary crops, the same quantity of sewage water was all but valueless. Nevertheless, in the first report of the Board of Health, dated July, 1849, it was said, "That in the local works which it is necessary to execute for the sanitary improvement of towns, an entirely new system of sewerage must be combined with a new system of house drainage, with a new system of water supply, and with a new system of removing and of applying the refuse of towns to agriculture." And Local Boards of Health were recommended to enclose waste land, "drain, and lay down upon it pipes for the distribution of the sewer manure, and then re-let it, prepared for cultivation, with a supply of the manure, on lease, and apply the surplus rents to the sanitary improvement of the town." In 1853, Mr. Chadwick addressed a letter to the Home Secretary, in which he stated that there were ten towns where inoffensive and beneficial distribution, by flexible pipe and jets, might be anticipated at an early date; and, in 1856, the same gentleman read a paper at the Free Trade Congress of Brussels, in which he spoke of a hundred towns in such a manner as to lead to the belief that they were about to derive crops and revenue from their sewage.—[Mr. Chadwick dissented.]—At any rate, such was the impression of Mr. Walker, of Rugby, of himself (Mr. Sidney), and many others. In this paper, at least, two examples only of enlightened cultivation were cited—the well-known liquid manure farm, of 170 acres, at Tiptree (where his worthy friend, Mr. Mechi, never grew good corn crops, or good root crops, until he followed the example of his neighbours, and gave his wheat 30s. an acre of solid guano, and drilled in a good dose of Lawes' superphosphate with his mangold), and the sewage manure farm of Mr. Walker, at Rugby, where, on 200 acres of grass land, on a wonderfully porous soil, a very good effect was produced by the liquid sewage in summer. Here, then, after all, were just two towns, or, rather, villages, using town sewage on the Deanston plan, Watford, where the machinery did not as yet work successfully, and Rugby. But the sewage manure theorists maintained that the absence of demand for the fertilising streams of cities was to be attributed to the stupidity of the British farmer. But had the farmer been standing still during the last sixteen years? During that period a million sterling had been invested in manufactories for producing annually hundreds of steam engines, threshing machines, drills, horse-hoes, clod-crushers, ploughs, harrows, &c., which were eagerly bought up. During that period millions had been sunk in draining, paid for by farmers' rents; hundreds of thousands of tons of guano, costing from £10 to £15 a ton, had been consumed. Manufactories of another costly manure, superphosphate of lime, had been established in every great town and every agricultural district. These manufacturers imported bones, bone ashes, and burned flesh from South America; they ransacked even the battle-fields of Europe for the same invaluable material; they imported apatite from Norway; and they did all this while sewage lay at their doors, offered to them gratis, and yet they did not find it worth while to accept it. After bringing forward other instances in support of his views, Mr. Sidney said that in thus following out the history of British agriculture it was impossible to doubt that the profitable use of liquid manure must depend on special and exceptional circumstances, as, for instance, where it could by gravitation be cheaply applied to grass land, of a quality sufficiently porous to absorb it. At Rugby it flowed away rapidly enough; yet even there it could not be all used, and the river was polluted. But few soils were like that of the Rugby farm. If he were asked why we neglect British, and send so far for Peruvian guano, at more than one hundred times the price of the home production, he would answer, why do we drink China tea instead of British herbs, Eastern sugar instead of British honey? Why do we wear American cotton and Italian silk, instead of British home-spun? Why do we prefer rosewood to British oak? Why toast our friends in foreign champagne instead of the domestic gooseberry? Because the foreign article was cheaper at the higher price.

Mr. Sheriff MECHI begged to state, in a very few words, the results of his own practical experience on this subject, and, in the first place, he would remark, that the earth was the best and cheapest deodoriser that they had. So effective was it that where he had applied large quantities of liquid manure of the strongest description, saturated with the dead bodies of animals in

large quantities, he had found his cattle feeding upon the pasture so treated within twenty-four hours after the application, and forty-eight hours after, no smell whatever was emitted. Again, with respect to liquid manure not being good for other crops than those of grass, he had found it beneficial to every description of crop, and so effective that, where it was applied in considerable quantities, he had seen its effects on subsequent crops for three or four years. Having a piece of land undone, and comparing it with that which was done, the result had been unquestionable for several years. If they doubted the power of the soil as a deodoriser, they had only to get some game that was high, wrap it in a cloth, and cover it with a few shovelsfull of earth, and, in half an hour, they would find that all unpleasant smell was removed. A labourer in his employ had assured him that when he used to be engaged in cutting up carrion for feeding hounds, the only way in which he could remove the smell from his hands was by washing them in clay water. But before they could apply liquid manure to clay lands they must be well drained. On chalky, gravelly, and sandy soils, they might put any quantity of liquid manure with effect, especially for those quick-growing crops which consumed large quantities of food by their rapid growth. But the great question was, to persuade the agricultural public that it was to their interest to use this description of manure. If sewage was profitable to be used by the farmer, it was useless unless the agricultural public were prepared to lay down the pipes to bring it upon their land. This could be done at a cost of something like £6 per acre. Having adopted the system himself, he could state as the result of his experience for the last four years, on his farm of 170 acres, that it was a most profitable operation. Applying the water of London alone—even without the 12,000 or 15,000 tons of ammonia—over properly drained land, would be profitable. The water meadows of Winchester and the Duke of Portland proved this. It had been said that liquid manure was not available during wet weather or frost. He would say that it could be applied in any weather except very severe frost, and even during frost it often had the effect of softening the ground. He hoped never again to hear it asserted that water cannot percolate through the stiff clays, for unless that notion were exploded, it was in vain to hope that agriculturists would apply the sewage of towns upon clay lands. The cost of its application was no longer a matter of doubt. There was a vast amount of prejudice to be got rid of before sewage manure would be of extensive application. Of its value there could be no question. London at the present time contained about an eleventh part of the population of the whole country, and probably the produce of one-eighth of the whole area of land was exhausted to feed London alone. The importance of a good manure would be fully appreciated by those who had to resort to expensive foreign manure to supply the exhaustion of the land in feeding the population of this metropolis. With regard to the deodorising process at Leicester now advanced, he would state that it was contemplated to carry it out at Chelmsford; originally it was intended to lay down a system of pipes and works for the purpose of irrigating the land, but there was at present a difficulty in obtaining the land required for the purpose on such terms as would justify the outlay.

Dr. COPELAND remarked, that in his opinion, if Mr. Bazalgette's plan of intercepting sewers were carried out, it would be a failure, injurious to the health of the metropolis, and would entail double the estimated expense. The subject of deodorising—or, more properly speaking, disinfecting—was one of great importance; for, unless that were done, no sanitary improvement would result. He objected to the use of quick-lime in the process, inasmuch as it set free the ammonia, whereas he would suggest the use of carbon (carbon being a fixer of ammonia), and the result would be a more useful manure. That was, however, objected to by Mr. Cooke, on the score of expense. In 1849, a patent was obtained for peat charcoal; it had been extensively employed, and was sold in Ireland at 1s. per bushel. This might be thought a high price for agricultural purposes, but if combined with other chemical materials it might, he thought, be advantageously used for disinfecting the sewage before it reached the larger reservoirs, or even in the reservoirs themselves. He thought that a mistaken notion prevailed as to the injurious effects that would result from these sewers, for he had reason to believe that the effects were not so bad as when the sewage was spread over the surface of the land. No doubt, as Mr. Sheriff Mechi had stated, the earth was the best deodoriser, but the great object was to deodorise long before the sewage reached that destination.

Dr. GLOVER said, that time did not admit of his speaking at any length on the subject, but he believed that deodorising processes might be carried out with success, and that the fact of several very impure waters being purified by filtration, was a proof of it. The great object should be to employ materials which were themselves excellent as articles of manure, and which, by absorbing the sewage, would become still more so. Dr. Glover referred to the experiment of M. Chevalier on animal charcoal as a deodorising agent, and stated that he himself had experimented on soot, and found it a powerful deodorising agent. He also referred to the action of sulphate of lime as a fixer of ammonia, and in conclusion stated that he believed the problem, though difficult of solution, was by no means impracticable.

Mr. WRIGHT said, although a member of the Metropolitan Board of Works, he was not there to defend that body. It was a favourite practice to point out in strong language the enormous amount of fertilising matter that was lost under the ordinary system of town sewage. He appealed to the chairman, as a chemist, and one acquainted with manufactures, whether the cost at which it could be saved was not an essential element in the question. Quartz might contain gold, but in so small a proportion that it would not pay the expense of extraction. He applied that remark to the subject before them. Until it had been shown that it would cost less to abstract the valuable matters in the sewage than the value when extracted, they must adopt the best plan they could for getting rid of it. He would instance ammoniacal liquor of gas works. The ordinary strength of that product in gas works was, that it took about 16 ounces of sulphuric acid to saturate a gallon of the liquor, and thus form a salt of ammonia. It was more profitable to sell it for a low price to parties who took it away from the gas works and manufactured from it a valuable chemical salt, than for the gas company to attempt the manufacture themselves. But the manufacture could not be carried on profitably if the dilution exceeded a certain per centage. Now the per centage of ammonia in sewage was infinitely less than in any ammoniacal ever made. He had hoped for more detailed facts as to the expenses at Leicester. If, as was stated, they were selling it at 2s. per ton, could they buy lime for the process at 2s. per ton? Those were the practical questions which required to be answered. He thought, that after the diversity of opinion they had heard that evening, to ask the Metropolitan Board to rush into this scheme, would be asking more than practical men of business would be inclined to concede. The Board of Works were doing all they could to bring the sewage to one or two points, and when there it could be operated upon. He would appeal to this large audience, whether what the Board were doing was not something like that which business men should do?

Mr. WILKINSON said he belonged to an increasing section of the Metropolitan Board, who believed that in deodorising would be found the successful solution of the great question of the day. He contended that they had nothing to do with the commercial consideration of the

question. The question was how they could most efficiently, in a sanitary point of view, effect the complete drainage of the metropolis. The Board of Works might be considered as a jury upon the question, and they wanted evidence to guide them. He could confirm all that had been stated by Mr. Cooke with regard to the sanitary effects of that system upon the town of Leicester, and the process might be carried on under their drawing-room windows without offence to any one. He considered the most magnificent results had ensued in a sanitary point of view from the adoption of the deodorising process; and as the representatives of the sanitary interest of the metropolis, it was the duty of the board to pause before they committed themselves to the vast expenditure proposed. They ought officially to send proper persons to examine carefully into this process. He (Mr. Wilkinson) was not wedded to any particular plan, but he believed that the deodorising principle would enable them to do the work most effectually and economically. He considered that it ought not to be thrown upon the Board of Works to determine this great question; it would be more satisfactory if a special commission were appointed for a work of such magnitude, which commission should embrace the best engineering and chemical talent of the day. He dissented from the opinion just expressed, that because the products were not at present commercially valuable, the deodorising principle ought not on that account to be considered by the Metropolitan Board.

Mr. RAWLINSON said that it was now pretty well decided that towns must be sewered, and houses must be drained, if health was to be preserved, and for that purpose the accumulated sewage must be disposed of; and as there were cases in which an immediate application to the land could not be made, some form of deodorising would be necessary. He (Mr. Rawlinson) could only say, that if the Leicester plan did not fully answer the purpose he was sorry to hear it, and most earnestly hoped all objections might be removed. Mr. Cooke had imputed the saving of life in Leicester to the deodorising. As this might be objected to, he begged to say that sewers and drains, without the deodorising works, had brought about equally beneficial results, and he only mentioned this fact that the arguments in favour of deodorising might not be weakened. The question should not be one of cost alone; if absolutely necessary to the health and comfort of the people, the work ought to be made compulsory, and a rate should be levied for the purpose of defraying the expenses. Much had been said about the proposed metropolitan works, and their great cost—if great works were to be carried out, the cost must be great, but not greater than the benefits to be conferred.

Dr. LETHEBY said, as the Medical Officer of Health for the City of London, he had looked with great interest at every scheme which had been advanced in order to effect the complete drainage of the metropolis, and he, in common with others, had devoted considerable attention to the question raised as to the effect of lime upon the sewage of the metropolis. Without entering upon the engineering part of the subject, he would direct his attention to the two chief arguments that had been advanced in favour of the scheme then brought before their notice. One related to the chemical influence of the lime. The constituents of the sewage of towns consisted for the most part of undigested matters, and when those were acted upon by lime—whether they were in an undecomposed state, or in a putrescent state, the lime precipitated the phosphates, which, in the act of falling, carried mechanically other matters existing in sewage waters, and there were left urea, uric acid, and other substances of value, wholly untouched. The process, therefore, he considered deficient in the first principles of chemistry. He need not say that the action of lime upon the various constituent matters of sewage water was well known to chemists; but he had himself put it to the test of experiment, and he found that lime acted upon the sewage matter, whether fresh or in a decomposed state, in such a manner that the great material which gave its value to guano—ammonia—passed away, and was lost. The lime did little more than precipitate the matters mechanically suspended. Another argument was, that the mortality of the town of Leicester had been very considerably reduced since that mode of disinfecting the sewage had been introduced. The tabulated return before them would at first sight indicate that fact, and if they relied upon it, they might conclude that the health of the town had progressed, *pari passu*, with the introduction of this system. But let them look at the other towns in the North-Midland counties, and they would find that there also, in precisely similar proportion, had there been an improvement in the state of the public health. By the returns of the Registrar-General for the last three years, he found that the improvement in the health of Leicester—upon which so much stress was laid, as connected with this particular system—was precisely the same as that which had taken place throughout the whole of England; thus the argument failed. He was therefore of opinion that the two points to which he had directed his remarks, viz., the chemical principle involved, and the sanitary result claimed, were not founded upon those sure data on which such schemes ought to be based, in order to gain attention as applicable to the exigencies of the metropolis.

Mr. COOKE said that the length of the discussion and the lateness of the hour would only admit of a very brief reply to the comments of the various gentlemen who had addressed the meeting. It had been said that he had ascribed the diminished number of deaths at Leicester to the system of deodorisation alone; but that was an error. He had ascribed this all-important fact to the general sanitary measures adopted at Leicester. It was true the putrid river Soar of former days had, since the erection of the deodorising works, become a pure stream of wholesome water, and the sickly residents on its banks had become healthy. This was a remarkable coincidence, at least. It had been said that quicklime liberated the ammonia of the sewage, and that the Leicester plan was, therefore, chemically wrong. He (Mr. Cooke) had stated that it was cream, or hydrate of lime, that was employed, and that the ammonia, in consequence, could not be, and was not, liberated by the process. It had been said that the chemist of the Agricultural College at Cirencester declared that in the dry bricks there was only ·72 per cent. of ammonia. He (Mr. Cooke) had shown that the dry brick lost its ammonia, and should not be taken as the product of the system. It had been said that the process was a fallacy, and the product worthless, because it did not sell. He (Mr. Cooke) had stated that it did sell, at a price that covered the outlay in production, and that 1,000 tons had been sold in the last fortnight. He was told that there was a fallacy in valuing the ammonia in manure at £60 per ton, as that was the price of the pure article. He replied, how, then, was guano valued? It contained sixteen per cent. of ammonia, and sold in the market in proportion to the quantity of ammonia in the sample. He was charged by a member of the Metropolitan Board with trying to force his plan upon the board. It was not his plan, but that of the board—of their engineer, Mr. Bazalgette—who recommended it for the western district, because "he had ascertained that the cost of the process of purification would be very much less than that of conveying the sewage to Barking-creek." That this circumstance mainly influenced him, although the increased engineering difficulties attendant on the other scheme had some share in forming his decision, and that the amount of saving in that district alone would be £12,000 per annum; and Mr. Bazalgette afterwards stated that if his (Mr. Cooke's) proposition for deodorising at the Lea river were adopted, "a further saving of nearly half a million might be effected." It was said that the plan had failed at Southampton. This was an error

The authorities had not adopted the plan, and their putrid sewage flowed into their stream at low tide, but he thought they would ultimately adopt it. Another gentleman urged that the English farmer would only use the pure guano, on the same ground that in private life tobacco was used instead of rhubarb leaf, coffee instead of chicory, champagne instead of gooseberry wine. He (Mr. Cooke) replied that that gentleman was wrong in each case. The counterfeit was extensively used because it was cheaper, but the deodorised sewage was no counterfeit; it was of low value, but still of value, and sold at the low price at which it could be produced, and for what it was worth. He (Mr. Cooke) showed, by sales that were going on, that it could be disposed of at a price which would cover working expenses, but the Metropolitan Board were willing to spend £38,000 per annum, without any return. He showed a saving of £1,200,000 per annum on the engineers' estimates. Another gentleman declared that irrigation was desirable, but that it infected the air. He (Mr. Cooke) submitted a plan for purifying the sewage water before it was employed for irrigation. He was told that the ammonia escaped in the effluent water, but the chemists could not detect it. Another gentleman, a member of the council, said that he (Mr. Cooke) had not done full justice to Mr. Wicksteed's plan, which had proved three great points, viz., that the feculent matter was separated by it without any nuisance, that the deposit was removed from under the clear water without exposure to the atmosphere, and that it was converted into a solid substance, easily removed, and of some value. He said that therein the main question was solved. He (Mr. Cooke) urgently warned the agriculturists of this country not to be led blindly by the chemists. They had been the best and truest advisers, but they would be found to be bad masters. Twenty years had passed since he had had to fight the cause of a great and novel undertaking, when the very mention of the electric telegraph was laughed at, and when he had not the great facts achieved to point to which he had in this instance. But truth would gain its victory, as it did then, and the scientific prejudices once overcome, the scientific adviser became the best and safest friend. The Leicester system was a great fact, which could not be shaken. Its adoption in London, under the guidance of experience and science, would be a great gain, and it was his (Mr. Cooke's) conviction that it would ultimately be adopted.

The CHAIRMAN said it only remained for him to move a vote of thanks to Mr. Cooke for his very valuable paper. With reference to the discussion that had taken place, he would allude to a matter in which he had been personally appealed to by one of the speakers, viz., that this question ought not to form a large subject of investigation because capital had not yet used it for speculative purposes. The whole history of manufactures was but the using up of waste materials for a long time unrecognised by capital, but which ultimately had produced the most important benefits to mankind. If such were the result of manufactures, surely the opinion of chemists that this material contains valuable properties for the food of our population, ought to receive more attention from capital, and they ought not to be deterred by any general statements that sewage manure could not be made valuable. He thought Mr. Cooke's advice, to refer the question to a commission of scientific men was better than that he had employed in his reply. He quite agreed that whilst they ought not to allow scientific men to be their masters, they ought to make scientific men their advisers. In carrying out the electric telegraph, Mr. Cooke, who knew much of the science of the subject, did not hesitate to avail himself of the scientific discoveries of other persons, or to employ their counsel in guiding him, and it was this, united with his own energy and power of business, which had led to such a successful result. The fact of his being in the chair had prevented him taking part in the discussion, but he did not wish to be supposed to be committed to a full approval of the plan before them. He, however, agreed that it ought to be further investigated, in which he thought scientific men could aid with their information in deciding the question whether this plan was one that could be economically adopted, or whether—economical or not—it could be adopted with safety to the community. This was a legitimate subject for scientific investigation, and for the counsel of scientific men.

A vote of thanks was passed to Mr. Cooke.

The Secretary announced, that on Wednesday next, the 17th inst., a paper by Professor Owen, F.R.S., "On the Ivory and Teeth of Commerce," would be read.

The following letters have been received since the meeting:—

"Sir,—There was no time for practical farming men to make any observations last evening, otherwise I should have stated that since I have been engaged in farming on rather a large scale (farming 560 acres), I have been constantly studying all the different modes now known for manuring and enriching my land at the least cost; and with respect to the manure made by Mr. Wicksteed's process, I should say that it is with the farmers merely a question of cost. If Mr. Wicksteed's solid manure contains ·73 per cent. of ammonia and 12 per cent. of animal matters (as the analysis of Mr. Voelcker proves) then one ton of it is worth to the farmer as much as 100 lbs. of guauo; and if the farm is near to the works, it may be cheaper for him to buy and distribute on his land 3½ tons of this manure, than 3 cwt. of guano; but that cost depends, of course, on the distance and expense of carrying this manure on to his fields. The great advantage of applying liquid manure by pipes, is the small cost of its distribution, as the engine will pump up and distribute manure at a cost of 1½d. per ton; whereas the carting of solid manure alone from the farmyard on to the fields and distributing it, will cost 4s. per ton. Also, when the manuring principle is applied to land dissolved in water, it permeates more rapidly through the soil, and becomes more quickly combined with it, than when put on the land in a solid state; and until the manuring principle has chemically combined with the soil, the food for plants is not produced. Professor Way has shown us, by one of his most valuable experiments, that when liquids, containing ammonia, are filtered through six inches of earth, containing such usual proportion of alumina as all corn lands have, all the ammonia is retained and chemically combined with the alumina, and the liquid is discharged free from it, wherefore it is more desirable to apply the manure dissolved in water, and, as is now the custom, to apply guano to the land in wet weather, that its ammonia may be quickly washed in; and I may here remark, in answer to one gentleman's observations, that Mr. Way has found that peat charcoal has not so good an effect in arresting ammonia from liquids as common earth, and it is therefore of no value for that purpose.

"If I could get a supply of liquid manure brought to my farm, I should be glad to receive it, and would distribute it over my land; but until that can be done, I see no reason why farmers should not use Mr. Wicksteed's solid manure, if its cost per ton, when put on the land, will not exceed the cost of 100 lbs. of guano. But, of course, if by Mr. Wicksteed's process the per centage of ammonia can be increased, its value to the farmer will also be greater.

"I am, &c.,
JOHN BETHELL."

"Sir,—In Mr. Cooke's paper of yesterday it was asserted 'that Mr. Wicksteed was the inventor of the lime process for deodorising and precipitating sewage.'

"As long since as 1847 a court of inquiry, consisting of the chairman of the meeting, Dr. Lyon Playfair, together with Sir Henry de la Beche, and one or two others, examined into my own invention on this subject, and reported, 'That it was a proper subject for an Act of Parliament,' which act was passed in the same year. Mr. Wicksteed was on that occasion heard by counsel before that court, which, however, decided in my favour.

"It was impossible for me last evening to call attention to my claims, which, however, I trust you will allow to appear in the same *Journal* which contains the report of last evening's proceedings. By so doing you will much oblige "Yours, &c.,

"WILLIAM HIGGS.

"24, Churton-street, Pimlico, Dec. 11, 1856."

HONORARY LOCAL SECRETARY.

The following gentleman has been appointed Honorary Local Secretary for Manchester:—

George Peel, Manchester.

EXAMINATION PRIZE FUND.

The following addition has been made to the Prize Fund:—

Sir J. W. Ramsden, Bart., M.P., £105.

Home Correspondence.

REMARKS ON MR. C. BINKS' PAPER.

SIR,—I was much surprised, on reading Mr. C. Binks' interesting paper "On some New Methods of Treating Linseed Oil," &c., to find that he had so completely overlooked several valuable memoirs which have been published on the very subject of his discourse, not only as to the method of investigation, but also the very substance he recommends to impart to linseed oil *rapid drying* properties. No one less deserves the following sweeping remarks of Mr. Binks than my master, M. Chevreul:—"But the labours of Chevreul went to determine their chemical constitution, not to investigate their peculiar changes under all kinds of extraneous action, and the peculiar chemical history of the changes the drying oils undergo formed no part of his admirable researches;" for M. Chevreul began to investigate fully the phenomena of the drying of oils in 1845, and published a most extensive and valuable paper in the Memoirs of the Academy of Sciences, 1850; and Mr. Binks cannot plead that this paper could not be known by him, for, after I gave my lecture at the Government Department of Science and Art, Marlborough House, Mr. Hart kindly undertook to make an extract of it, which he published in several numbers of the *Builder*, see Vol. XIII., pages 109, 193, 243, and 373, 1856. If Mr. Binks will read M. Chevreul's Memoirs, he will find that this learned chemist investigated the drying properties of oils exactly by the method claimed by Mr. Binks, and he will find that M. Chevreul made and described several hundred experiments. My master not only examined the various atmospheric influences which assist or impede the drying of linseed and other drying oils, but also the action of the same when boiled with litharge, or oxide of manganese, the influence of various pigments on the same, and lastly, the action which various surfaces have in facilitating or retarding the drying of oils.

As to the employment of the hydrate of protoxide of iron, or nickel, and especially that of hydrate of protoxide of manganese, for imparting at natural temperatures, or at a moderate heat, drying properties to linseed oil, Mr. Binks will find a paper by Messrs. E. Barruel and Jean, published in the *Chemist*, Vol. IV., p. 412, 1852 and 1853, in which those gentlemen recommend the above hydrated oxides for the above purposes, and, what is not less extraordinary is, that the very explanation of the mode of action of these hydrates of protoxides in determining the rapid drying of linseed oil, is identical with that given by Mr. Binks as his own.

I am, &c.,

F. CRACE CALVERT.

DRYING OILS.

SIR,—The desire to hear what the manufacturers of boiled oil and varnish had to say on the subject of Mr. Binks' paper, and the lateness of the hour, prevented my making any remark, as a consumer of both articles, as to their present defective points.

All persons interested in their use must hail with satisfaction the prospect of being able to procure a pale or colourless drying oil at a moderate price, difficult as it is to believe that mixing an oil of nearly the colour and consistence of treacle, will not injure the purity of white and other delicate paints; the mere opening a discussion on the subject, and giving consumers an opportunity of expressing their wants, will probably lead to improvements. In fact, it appears that the difficulty of procuring a colourless drying oil, has prevented varnish makers making any considerable improvements in copal varnishes for carriages during the last thirty years. From all the information I can obtain on the subject, the only advance made during that time, is, that many manufacturers can now produce as good an article at a lower price, as was only made by one house thirty years ago; the colour is still dark, and injures delicate paints.

At the time I was occupied in preparing the report on the carriage department of the Paris Exhibition last year, and obtaining information connected with the details of manufacture, I found exhibited by Messrs. J. Colin and Co., of Breslau, Silesia, samples of pale drying oils, prepared in three manners.

First, with borate of manganese.

Second, with phosphorus.

Third, without heat.

Can Mr. Binks inform us if he has tried any of these methods, or will any manufacturer try them, and give us the result of his experiments?—I am, &c.,

GEORGE N. HOOPER.

28, Haymarket, Dec. 5.

TECHNICAL WORDS.

SIR,—As I am about to publish a Supplement to my "English Dictionary," I shall feel much obliged to any Members of the Society, or readers of the *Journal*, who will favour me with additional words, and particularly trade terms.—I am, &c.,

HYDE CLARKE.

42, Basinghall-street, 6th Dec., 1856.

THE PRICKLY PEAR.

SIR,—The juice of the fruit of the prickly pear, the *Cactus opuntia* of some botanists, and *Opuntia vulgaris* of others, which you forwarded to me some time back, with a request to ascertain its properties as a dye, has, so far as the quantity sent would admit, been submitted to different trials upon cloth, both woollen and cotton, without mordaunts and mordaunted.

The juice, although of itself a beautiful deep, rich, purple rose colour, did not, under any circumstances, convey this tint to the material with which it was tested.

Cotton cloth prepared with different mordaunts took up colour in a very imperfect manner. The shades varied according to the mordaunts employed, and were from a grey to a brownish black. All were of a dull hue, and unstable, being removed to a large extent by boiling with water only, consequently of little or no value.

With woollen cloth mordaunted I was more successful, and with a mordaunt of a tin salt I secured a bright blue black colour, which was comparatively stable, and resisted considerably the soap bath. I am sorry to say, however, that time has the effect of changing the colour of this cloth. The piece accompanying this, and which you will notice is of a dull brownish purple colour, was the same which I exhibited to you about six weeks back, and was then, as you may remember, of a rather beautiful blue black.

I am, &c.,

DUGALD CAMPBELL.

7, Quality-court, Chancery-lane, Dec. 4, 1856.

BRUSSELS ECONOMIC EXHIBITION.

SIR,—I find that I was misinformed when I stated, in my report on the Brussels Exhibition of Domestic Economy,* that the article on the Building Department, which I quoted from the *Builder* of Oct. 4, was by H. Roberts, Esq., the honorary secretary of the Labourers' Friend Society. I am not aware by whom that article was written, but I am told that the sum allotted by the French Government towards the erection of workmen's houses in France was 10,000,000f., instead of 1,000,000f.

I am, &c.,

T. TWINING, Jun.

Perryn House, Twickenham, Dec. 3, 1856.

EXAMINATIONS.

SIR,—A letter appears in the *Journal of the Society of Arts* of Friday last, in which the writer expresses his regret that the Council have resolved to exclude certificated masters from their examinations.

It seems to me that three reasons may be assigned to justify them in coming to such a decision:—

1. It is unnecessary to provide examinations for that portion of society.

2. It would be unfair to those for whom the examinations have been established.

3. It would tend to bring the Society of Arts into direct collision with existing institutions.

The intention of the Council has been to supply a want of the age, and whilst they keep this object steadily in view they will not fail to command the respect and support of the more thoughtful part of the community.—I am, &c., ROBERT HONEY.

Cowper's House, Huntingdon, Nov. 24, 1856.

RAILWAY ALARM FOG-SIGNAL.

SIR,—My attention was engaged to make an improvement in alarm-signals for railways in consequence of the terrible disaster on the railway near Straffan, in Ireland, nearly three years ago. Colonel Beamish, director of the Cork and Bandon Railway, had six fog-signals placed on the rail at the Cork terminus, and when the engine passed over them two or three failed to explode. I requested that one, which was not tested, should be opened, and I found that the gunpowder within was *caked*, as if from damp, the three iron nipples were rusted, and the percussion caps on them rendered defective from verdigris; the circular tin case was also nearly eaten through with rust. Recollecting that the composition with which I charged my rifle percussion-shells, as far back as the year 1823, made a louder and a sharper report than any gunpowder I could find, I thought this composition—equal parts by weight of chloride of potass and sulphide of antimony, both pulverised—would be the best adapted for charging my fog-signals, which are made of paper, varnished over to make them water and damp-proof; they are exploded by means of my patented glass tube-ignitor, which cannot take rust or become impaired by any length of time in keeping. The weight of my signal is not quite *half* that of the tin signal now in use, while its report is louder and sharper.

I am, &c.,

J. NORTON.

Journal of the Society of Arts, Vol. IV., p. 781.

MEETINGS FOR THE ENSUING WEEK.

MON. London Institution, 7. Dr. Tyndall, "On the Nature and Phenomena of Light."
Architects, 8. Mr. Owen Jones, "On the Leading Principles which appear to reign in the Composition of Ornaments of every period—from the Grammer of Ornament."
Chemical, 8. Mr. A. G. Anderson, "On the Saponification of Resin."

TUES. Civil Engineers, 8. Anniversary.
Linnæan, 8.
Pathological, 8.
Statistical, 8.

WED. London Institution, 8. Conversazione.
Society of Arts, 8. Professor Richard Owen, F.R.S., "On the Ivory and Teeth of Commerce."
Geological, 8. I. Captain Spratt, "On the Tertiary Freshwater Deposits of the Western Portion of the Grecian Archipelago." II. Mr. John Wolley, "On an Ice-carried Boulder at Borgholm." III. The Rev. Mr. Clarke, "On the Occurrence of Volcanic Bombs in Van Dieman's Land." IV. Dr. Richardson and Mr. E. Browell, "Analysis of Waters from the Turko-Persian Frontier." V. Messrs. Hillier and Moyle, "On some Minerals from Siam."

THURS. Royal Society Club, 6.
Numismatic, 8.
Antiquaries, 8.
Philological, 8.
Royal, 8½.

SAT. Asiatic, 2.
London Institution, 3. Mr. T. A. Malone, "On Experimental Physics, chiefly in Relation to Chemistry."
Medical, 8.

PATENT LAW AMENDMENT ACT.

APPLICATIONS FOR PATENTS AND PROTECTION ALLOWED.

[*From Gazette, November 28th*, 1856.]

Dated 14th November, 1856.

2691. John Sutherland, Paddington—An improved railway break.
2692. Henry Clarke Ash, 11, Park Place South, Chelsea—Improvements in railway signals.
2693. Dan Saul, and Peter Williams, Swinton, Lancashire—Certain improvements in machinery or apparatus for spinning and doubling cotton and other fibrous materials.
2694. Andrew Symington, Kettle, Fife, N.B.—Improvements in apparatus for drying yarns and woven fabrics.
2695. Christopher Binks, City of London—Improvements in converting iron into steel, and in giving a coating of steel to iron.
2696. Archibald Reid, Sidmouth-street, Regent-square, and Charles O'Neil, Golden-square—Improvements in treating metallic ores to obtain copper.
2697. John Crawley, Wood-street, Cheapside—Improved machinery for stitching fabrics.
2698. James Greaves, Gerrard-street, Soho—An improved construction of ladies' side saddle. (A communication.)
2699. John Aitken, Islington—Improvements in the furnaces employed in the manufacture of iron or other metals.

Dated 15th November, 1856.

2700. Nicolas Pierre Joseph Leseure, 29, Rue de l'Echiquier, Paris—An improved embroidering machine.
2701. Henry Hawes Fox, 17, College-hill—Improvements in manufacturing brushes.
2702. Deane John Hoare, Mortimer-street, Cavendish-square—Improvements in the manufacture of iron.
2703. Robert Mushet, Coleford, Gloucestershire—Improvements in the manufacture of iron.
2704. Andrew Barclay, Kilmarnock, Ayrshire—Improvements in the manufacture of iron.
2705. George Davies, 1, Serle-street, Lincoln's-inn—An improved paper suitable for the filtration of liquids, the dressing of wounds, and for the manufacture of envelopes, bags, bands, and for other similar purposes. (A communication.)
2706. John Billing, Abingdon-street, Westminster—Improvements in chimneys.
2707. George Pye, Ipswich—An improvement in treating and bleaching cotton.
2708. Henry Blackburn, Butterworth Hall, near Rochdale—Improvements in billies and mules for slubbing and spinning wool, cotton, or other fibrous materials.
2709. John Drew, Back-hill, Middlesex—Improvements in library tables or desks.
2710. Nathan Robinson, John Lister, and Henry Stevenson, Bradford, York—Improvements in looms for weaving.
2711. Christopher Binks, London—Improvements in the manufacture of iron and steel.

Dated 17th November, 1856.

2712. Thomas Cope, Liverpool—Improvements in tobacco-cutting machines.
2713. Alexandre Marie Joseph Eeckman, Lille, France—A mechanical bakery and cookery.
2714. Joseph Worthington, Manchester—An improved mode of signalling from the guard to the engine driver on railway trains.
2715. Constnatin Michel, Lyons, France, and Isidore Antoine Maret, Paris—Making atmospherical observations.

2716. William Hawkes, Birmingham—A new or improved machinery for applying steam power to the ploughing of land, and other agricultural operations.
2717. Esteves Blanchon, Blois, France—Machinery and apparatus for marking and boring leather and other similar substances, for making and cutting screwed pins, and for uniting leather and other similar materials. (A communication.)
2718. George Jones and Joseph Reece Jones, Liverpool—An improved life-boat.

Dated 18th November, 1856.

2719. John Wilson, West Bromwich, Stafford — Improvements in springs for railway and other carriages.
2721. Samuel Cunliffe Lister, Manningham, near Bradford, York—Improvements in spinning.
2722. Frederick Arthur Magnay, Taverham Mills, Norwich—Improvements in damping paper for printing.
2723. Richard Butterworth, Chelsea—Improvements in the means of securing the ends of rails for railways.
2724. Samuel Dyer, Bristol—Improved mechanism, applicable to propelling ships and vessels, applicable also as power machinery for ships' purposes.
2725. John Grieve, Bank-park, Tranent, Haddington—Improvements in chimney cans.
2726. Henry Bessemer, Queen-street-place, New Cannon-street—Improvements in the manufacture of iron.

[*From Gazette, December 5th*, 1856.]

Dated 13th September, 1856.

2142. Edward Green, Wakefield—Improvements in scrapers employed to cleanse boiler tubes and flues for economising fuel.

Dated 25th October, 1856.

2512. Heinrich Hochstaetter, Darmstadt—Improvements in obtaining instantaneous light.

Dated 7th November, 1856.

2624. Amos Holt and Jabez Bentley, Cardigan Mill, East Ardsley, near Wakefield—Improvements in machinery for weaving stuff and other goods.

Dated 15th November, 1856.

2681. The Honourable William Erskine Cochrane, 5, Osnaburgh-terrace, Regent's-park—Improvements in the permanent way of railways.

Dated 19th November, 1856.

2727. William Brindley, Moorgate-street—Improvements in the treatment and application of papier maché for covering floors, roofs, and other like useful purposes.
2729. Henry John Distin, 31, Cranbourn-street, Leicester-square—Improvements in cornets and other wind musical instruments. (A communication.)
2730. William Smith Churchill and James Bradshaw, Stalybridge, Cheshire—Improvements in machinery or apparatus for drying yarns or fabrics, applicable to machines for sizing or dressing yarns or threads to prepare them to be woven.
2731. John Jones, Middlesborough-on-Tees, Yorkshire, and Edward Jones, Liverpool—Improvements in the manufacture or production and treatment of metal castings.
2732. John Lord, Rochdale—An improved admixture or compound to be employed as a substitute for oil in the treatment of animal wool preparatory to "carding."
2733. James, Earl of Caithness, Barrogill-castle, Caithness, N.B.—Improvements in driving belts, straps, or bands for machinery, and in the application and use thereof.
2734. William Edward Newton, 66, Chancery-lane—An improvement in centrifugal pumps. (A communication.)
2736. George Watson, Manchester, and Cornelius Satterthwaite, Preston—Improvements in the manufacture of fire lighters.
2738. Alfred Watson and Alfred Hamlyn Williams, Cornhill—An improved cap or top for scent bottles.
2739. Samuel Fox, Deepcar, Sheffield—Improvements in machinery for drawing wire and tubes.
2740. Louis Adolphe de Milly, Paris—Improvements in the manufacture of fatty acids.
2741. Samuel Fox, Deepcar, Sheffield—Improvements in heating steel wire and tubes, also ribs and stretchers of umbrellas and parasols for hardening, and in apparatus for straightening wire and tubes.

Dated 20th November, 1856.

2742. Edwin Salt, Bolton-le-Moors—An improved paper-cutting machine.
2743. James Montgomery Gilbert, Manchester—Improvements in certain machines for etching or engraving.
2745. Peter Armand le Comte de Fontainemoreau, 39, Rue de l'Echiquier, Paris—Improved apparatus for preparing carbonic acid gas and impregnating liquids therewith. (A communication.)
2746. Charles François Jules Fonrobert, Berlin—Improvements in the manufacture of boots and shoes. (Partly a communication.)
2747. Charles François Jules Fonrobert, Berlin—Improvements in the manufacture of insulated wires for electric telegraphs. (Partly a communication.)
2748. Thomas Francis Joyce, Birmingham—Improvements in joining, supporting, and strengthening the rails of railways.
2749. William Morgan, 48, Gloucester-terrace, Hyde-park—An improvement in heating parts of cylinders and other hollow bodies of iron to a welding heat.
2750. Robert Brock Benson, New York—Improvements in reefing sails.
2752. Richard Eaton, 2, Sussex-terrace, New-road, Battersea—Improvements in apparatus for buffing on railways, and for other purposes.

Dated 21st November, 1856.

2753. Louis Dartois, 39, Rue de l'Echiquier, Paris—An improved machine for the cleansing of textile and fibrous substances.
2755. John Norman, Liverpool—Improvements in propelling navigable vessels.
2757. John William Clare, White-street, Saint George the Martyr, Surrey—Improvements in preventing, removing, consuming, and condensing smoke and noxious vapours, and in apparatus for those purposes.
2759. Frédéric Ludewig, Paris—An improved leaven.
2761. William Edward Newton, 66, Chancery-lane—Improvements in machinery for spinning or twisting fibrous substances. (A communication.)
2763. Joseph Barrans, New Cross, Surrey—Improvements in apparatus for applying oil or lubricating fluid to the axles of railway carriages and locomotive engines.
2765. Richard Archibald Brooman, 166, Fleet-street—A method of and preparation for rendering textile and other like fabrics sanitary and disinfecting agents. (A communication.)
2767. Thomas Roberts and John Dale, Manchester, and John Daniell Pritchard, Warrington—Improvements in obtaining and purifying oxalate of soda, which improvements are also applicable to the manufacture of oxalic acid.

Dated 22nd November, 1856.

2769. William Thomas Henley, St. John's-street-road, Clerkenwell—Improvements in electric telegraphs. and apparatus connected therewith.
2771. Alexander Robert Terry, 24, Great George-street, Westminster—Improvements in sawing, splitting, cutting, and binding kindling wood.
2773. Edward Tucker, Belfast—Improvements in preparing and drying glue and gelatinous matter.
2775. Richard Archibald Brooman, 166, Fleet-street—Improvements in the manufacture of artificial wines, or beverages to be substituted for wines, and in apparatus for aiding fermentation. (A communication.)
2777. William Edward Laycock, Sheffield—Improvements in looms for weaving.

Dated 24th November, 1856.

2781. George Salt, Saltaire, Yorkshire—Improvements in weaving carpets and other piled fabrics.
2783. James Kennedy Martin, Dundee, Forfar, N.B.—Improvements in hoisting or purchase apparatus for ships and vessels.
2785. Charles John Lewsey, Albion-terrace, Commercial-road East—Improvements in sugar-cane mills.
2787. Henry Brickley, Stratton, near Cirencester—Improvements in mills for grinding.
2789. John Orr, Glasgow—Improvements in the manufacture of pile fabrics.

Dated 25th November, 1856.

2793. Henry Bougleux, Leghorn—Improvements in the construction of steam-boilers.

WEEKLY LIST OF PATENTS SEALED.

December 5th.

1359. William Denny Ruck and Victor Touche.
1365. Robert Ferrier.
1366. James Holdin.
1367. James Holdin.
1389. Rd. Archibald Brooman.
1407. Hypolitte Mège.
1411. Peter Armand le Comte de Fontainemoreau.
1464. Charles Minne and Amand Colson.
1466. Jean Charles Lefevre Lacroix.
1477. Edwin Hardon and Joseph Henry.
1487. Jules Etienne Lafond.
1505. David Macdonald.
1609. Alfred Vincent Newton.
1701. James Lawrence Crockett.
1705. James Lawrence Crockett.
1792. Robert Thatcher.
1793. John Knowles and William Buxton.
1913. William Tranter.
1923. Thomas Scott.
2229. Richard Husband.
2235. James Cottrill.
2281. Henry Jenkins.
2378. Frederick Albert Gatty.

December 9th.

1369. John Ellis.
1370. Benjamin Smith and William Kalthoff.
1378. Perceval Moses Parsons.
1384. William Henry Westwood, Thomas Wright, and Edward Wright.
1399. William Massey.
1495. Robert Wilson Chandler and Thomas Oliver.
1513. Andrew Shanks.
1604. Frederick William Hoffman.
1606. Julien François Belleville.
1712. Rd. Archibald Brooman.
1765. George Spence.
1831. Thomas Green.
1861. Alexandre Théodore Nicolas Goll.
2030. Alfred Vincent Newton.
2115. Stephen White.
2265. David Law and John Inglis.
2298. Alfred Vincent Newton.

PATENTS ON WHICH THE THIRD YEAR'S STAMP DUTY HAS BEEN PAID.

December 1st.

2812. Jonathan Saunders.

December 2nd.

2834. William Edward Gaine.
2906. Samuel Messenger.

December 4th.

2823. Matthew Andrew Muir.
2865. Richard Eccles, John Mason, and Leonard Kaberry.
2872. John Bourne.
2891. Wm. Frederick Plummer.
2951. Auguste Edouard Loradoux Bellford.
2964. Archibald Thomson.

December 5th.

2837. Julian Bernard.
2839. Alfred Vincent Newton.

December 6th.

2846. William Thomas Henley.
2860. Arthur James.